The North Atlantic Coast

Cooperative Ecosystem Studies Unit

A Strategic Vision
for the
Future

March 2000

Introduction

The North Atlantic Coast Cooperative Ecosystem Studies Unit (NAC-CESU) was established in June 1999 by cooperative agreement between the Department of Interior (National Park Service and US Geological Survey-Biological Resources Division) and the host institution, University of Rhode Island, with its partner institution, University of Maryland-Eastern Shore. The NAC-CESU is part of a nationwide network of biogeographically focused programs being established to provide research, technical assistance, and education to federal land management, environmental and research agencies. The NAC-CESU will focus on coastal ecosystems of the North Atlantic coastal zone from Maine to the Chesapeake Bay in Virginia (Fig 1). NAC-CESU activities will encompass all ecosystems of coastal watersheds, including barrier islands, estuaries, nearshore oceanic environments, salt and freshwater wetlands, coastal ponds, plus terrestrial watersheds and processes that affect the coastal environments.

The NAC-CESU is a unique collaboration, bringing together a wealth of technical knowledge and expertise that will allow for the development of innovative and creative solutions to the many of social and environmental issues that confront our nation's coastal ecosystems. A five-year strategic plan for the NAC-CESU will guide the general direction and fundamental focus of the NAC-CESU program. Annual work plans will outline specific research projects, technical assistance activities, training opportunities, and cooperative education endeavors.

A discussion of research directions and needs for the NAC-CESU came about through a workshop held in January 2000 at the University of Rhode Island. Present at the workshop were representatives from the National Park Service, USGS-Biological Resources Division, USGS-Geologic Division, Environmental Protection Agency, NOAA-National Estuarine Reserve Research System, University of Rhode Island and University of Maryland-Eastern Shore (Appendix I).

Discussions from the workshop were used to develop a strategic vision for the North Atlantic Coast Cooperative Ecosystem Studies Unit. This document identifies the components of a CESU research project or activity, identifies priority directions for research and technical assistance activities, and discusses specific activities and programs to be sponsored by the CESU.

Components of a CESU Research Project or Activity

The philosophy of the NAC-CESU is to provide information that has important management implications, is based on good science, provides training to federal scientists, provides special educational opportunities, and supports research that is complementary to existing information. Research projects that address these elements and are relevant to the coastal ecosystems found within the geographical scope of the NAC-CESU are considered priority CESU endeavors.

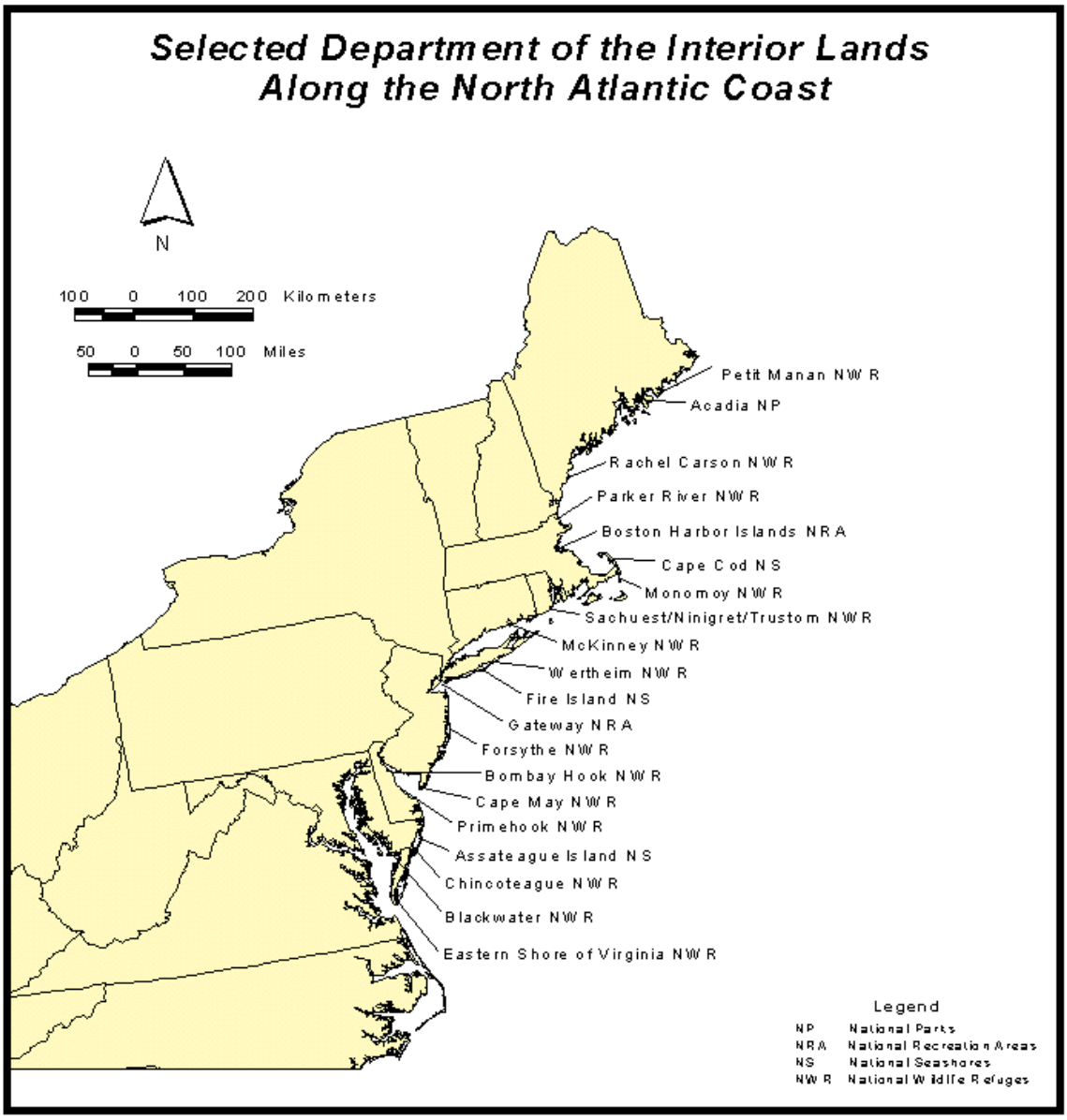

Figure 1. Geographic scope of the North Atlantic CESU. Many of the Department of the Interior coastal units are listed.

More specifically, NAC-CESU activities should:

- Address a natural resource management issue that is relevant to the protection, conservation and management of federal lands. It is expected that most CESU projects will be specifically conducted on federal lands; however, there may be situations when a CESU project will have multiple sites (i.e. many non-federal) or it could be justified that an entire CESU project could be conducted on non-federal lands. The key is that the project results in specific findings that are directly relevant to addressing coastal problems of federal land managers.
- Take full advantage of the research expertise of the host institution (University of Rhode Island), partner institution (University of Maryland-Eastern Shore), and include the participation of federal research partners (National Park Service, US Geological Survey), and other participating partners.
- Take place within the geographic scope of the NAC-CESU.
- Be interdisciplinary in nature.
- Provide opportunities for undergraduate and graduate students from diverse backgrounds.
- Include close collaboration with CESU partners and provide technical assistance to natural resource management agency personnel.

Research and Technical Assistance Directions

Federal land holdings along the North Atlantic coast are islands of protected lands within the urban sprawl of the Northeast. These areas have special natural resource management needs that must be tailored to the protection of fragile ecosystems in the face of increasing urban pressures. The coastal counties of the northeast United States are the most densely populated coastal regions in the country. Sixteen percent of the entire United States population resides in the coastal zone, and the density of human populations within this narrow fringe is increasing (Culliton et al. 1990). Recent censuses estimate that population densities in coastal counties are growing at three times the rate of the total United States population (Culliton et al. 1989). This increasing urban pressure surrounding and within federal land holdings has significant impacts on the coastal environment. Additionally, federal land holdings provide opportunities for the public to experience the natural environment, and management decisions must reflect the need to balance visitor experience with the conservation of natural resources. Research and technical assistance activities of the NAC-CESU should be designed to address such natural resource management issues facing these federal lands.

Several research areas and needs were identified during the NAC-CESU workshop; however, a few were of particular importance as they addressed broad overarching concerns confronting coastal ecosystems of the northeast. Among the top research priorities and needs were nutrient enrichment and contaminants, landscape and restoration ecology, coastal geomorphic processes, monitoring and modeling long-term changes, and data and information exchange. Specific research topics, garnered from the

CESU workshop as well as other sources (USGS Patuxent Wildlife Research Center 1999; Orson et al. 1997; Nordstrom & Roman 1996; Roman et al. 1987), are detailed at the end of each section. Activities of the NAC-CESU will strive to address these broad topics.

Nutrient Enrichment and Contaminants

As populations grow, increases in anthropogenic loading from many sources (fertilizers, agricultural waste, sewage, ground water, fossil fuel emissions) contribute to the eutrophication of coastal waters (Portnoy et al. 1998; Jaworski et al. 1997; Nixon 1995; Valiela et al. 1992). Small shallow systems are often the first to be affected by nutrient enrichment. Nutrient enrichment can cause a cascade of events at several tropic levels. Impacts include increases in phytoplankton production and macroalgal biomass, which have been linked to the decline of seagrass habitat (Kinney & Roman 1998; Short et al. 1996; Harlin 1995; Valiela et al. 1992). Other ecosystem perturbations, such as anoxic and harmful algal blooms, have also been linked to eutrophication (Paerl 1997; Cosper et al. 1989). These events, in turn, may lead to detrimental effects on fish and benthic communities (Valiela et al. 1992).

In addition to nutrient enrichment, urbanization has caused a rise in the concentration of contaminants in coastal ecosystems. Regional patterns in the concentrations of metals (copper, lead, mercury and zinc) and toxins (PAHs, DDT, PCBs) have all been positively correlated with the degree of urbanization within coastal watersheds (Cochran et al. 1998; Breault & Harris 1997; Golomb et al. 1997a, 1997b; Mason et al. 1997).

Some specific research areas related to nutrient enrichment and contaminants are:

- Evaluate and identify coastal ecosystem responses to changes in the magnitudes of nutrient enrichment and/or contaminant inputs.
- Determine the thresholds for nutrient enrichment and contaminant inputs and their effects on ecosystem function and structure.
- Identify, quantify and monitor sources and fates of nutrient and contaminant inputs to coastal ecosystems.
- Develop and test best management practices to minimize the impact of nutrient and contaminant effects on natural resources.
- Identify and develop biotic indicators of ecosystem stress related to nutrient enrichment and contaminants.
- Conduct functional assessments for coastal ecosystems and habitats.
- Develop predictive models for nutrient and contaminant inputs and processes, and their related biotic effects.

Landscape Ecology

Development and associated activities within the recreationally oriented coastal zone is increasing at a significant rate (Culliton et al. 1990). This development has the potential

to significantly impact natural resources within federal coastal lands. Coastal ecosystems are dependent upon high quality resources to sustain the biotic complexity inherent in coastal, estuarine, and nearshore oceanic environments. Changes in land use patterns and urbanization of coastal watersheds threatens the quality of these resources (Roman et al. in press; Jaworski et al. 1997). Threats to natural resources may originate from the cumulative effects of residential, commercial, industrial and agricultural activities adjacent to or within the watersheds of coastal lands, or may be associated with more widespread activities such as aquaculture, fisheries harvest, maintenance of navigational waterways, oil spills and ocean dumping. More localized land use impacts may occur from shoreline structures, which alter natural sediment dynamics, or the effects of inholdings, residential communities, visitor services and infrastructure (i.e. roads) that may also significantly impact resources within federal lands. Stress on groundwater resources is just one example of the pressures facing coastal ecosystems. Groundwater supplies freshwater for domestic, industrial and agricultural use, as well as supporting freshwater ponds, wetlands, and estuarine environments. Groundwater withdrawls and saltwater intrusion are of particular concern in some regions, such as Cape Cod, where groundwater is the principle source for both human usage and coastal wetlands (Godfrey et al. 1999).

Federal lands along the North Atlantic coast support a wide array of biological communities including nearshore benthic and littoral communities, coastal wetlands, grasslands, shrublands, maritime forests, and freshwater wetlands. The diversity of these communities and their spatial relationships determine habitat quality for the fish, wildlife, threatened, rare and endangered species, and other biotic resources of federal lands. The size, spatial relationships, and structure of these biological communities are undergoing constant change in response to natural processes and human-disturbances throughout the coastal zone.

Climate change is influencing the structure of biological communities. Global mean temperatures are expected to rise 1-3.5 ºC by the end of the next century (Watson et al. 1996). Increased global temperatures may shift species distributions, alter physiological functions such as growth, metabolism and reproduction, or even result in the loss of critical estuarine habitats such as seagrass beds (Short & Neckles 1999).

Human activities have progressively altered the coastal ecosystem causing many endemic habitats and species to become increasingly rare. An increase in non-native and invasive species has occurred in many areas, often obscuring the structure and function of endemic communities and resulting in significant ecosystem impacts (Bertness 1999).

Research is needed to provide a predictive framework for the management, conservation, and protection of these diverse communities, to assess problems facing natural resources, to detect changes on various temporal and spatial scales, and to minimize impacts on habitat quality and diversity. Due to the visitor-based nature of National Parks, the balance between visitor experience and preservation of natural resources can often be a particularly difficult management issue. The ability to predict community responses to

landscape changes will allow management personnel to institute prudent scenarios to protect the ecological integrity of these natural resources.

Some specific research areas related to landscape ecology:

- Determine and document the role of coastal parks and refuges within the highly urbanized coastal corridor in terms of maintaining regional biotic diversity, preserving rare species, and providing social values through open space and recreational activities.
- Evaluate the incremental and cumulative effects, at all scales, of landscape use patterns and alterations on coastal ecosystems.
- Identify linkages and connectivity among habitats, tropic levels and/or organisms and evaluate the effect of land-use alterations on these relationships.
- Identify immediate and long-term threats from land-use and nearshore-use activities to living resources in the coastal zone.

Restoration Ecology

Restoration has become increasingly widespread as a management tool to reclaim functionality of altered or lost ecosystems. An estimated fifty percent of the nation's coastal wetlands have been lost (Dahl 1990; Tiner 1984). In the northeastern United States, salt marshes and other coastal habitats have been particularly impacted. Salt marshes have been filled, drained, mosquito ditched, and tidal exchange altered by dikes, impoundments, roads and water control structures. The loss of salt marsh habitat is particularly striking in New England, where for example, in Connecticut, 30-50% of tidal marshes have been lost as a result of human disturbance (Rozsa 1995; Metzler & Tiner 1992). Submerged aquatic vegetation habitats are also declining throughout the coastal United States. Large-scale losses of seagrass habitat from estuaries and coastal ponds have been documented throughout the northeast coastal zone (Short & Burdick 1996; Short et al. 1996; Orth & Moore 1981). Changes in water quality and clarity, fishery related activities, and scaring from moorings, propellers and vessel wakes have all contributed to the decline of seagrass habitat (Fonseca et al. 1998).

Restoration of these and other habitats is occurring throughout the North Atlantic region at an increasing pace (Fonseca et al. 1998; Davis & Short 1997; Roman et al. 1995; Confer & Niering 1992; Sinicrope et al. 1990; Roman et al. 1984). Research is needed on the responses of communities to restoration activities. Additionally, evaluations of ecosystem functionality of restored systems will serve as benchmarks to evaluate restoration success and the knowledge gained from such studies will be crucial to the improvement of future restoration strategies.

Some specific research areas related to restoration ecology:

- Identify critical habitat conditions and/or species to protect, restore, and manage.
- Identify the natural conditions and attributes of sensitive habitats and develop guidelines utilizing these attributes that will optimize restoration success.
- Quantify ecosystem responses to habitat restoration and enhancement activities.

- Identify and develop ecological indicators, standards, and criteria for evaluating the success of restoration efforts.

Coastal Geomorphic Processes

The majority of federal land holdings in the NAC-CESU are facing a wide variety of problems associated with coastal geomorphic processes. Infrastructure (roads, facilities), historically significant areas, recreational-use areas (campgrounds, beaches), and interpretive areas are continually threatened by shoreline processes. Management decisions concerning the re-location of destroyed facilities and the need to protect, or not to protect, existing and threatened facilities must be based on a detailed knowledge of geomorphic shoreline processes. Rates of ocean and bay shoreline change, dune migration and other processes must be critically assessed for effective facilities management. In many cases, these problems are the result of human disturbance either in or adjacent to federal lands. Impacts to sediment supply from stabilized inlets, the loss of overwash habitat resulting from dune stabilization for storm protection, and to the inherent incompatibility of urban development with the dynamic nature of coastal barrier features are just a few examples.

Natural coastal geomorphic processes and sea level rise compound these issues. The coastal barrier system is a dynamic environment continually shaped by storm events, wind, wave and tidal action, sediment transport and removal, as well as regional geology and geomorphology (Leatherman & Zaremba 1986; Cleary & Hosier 1979; Kraft et al. 1979). Shoreline erosion and overwash areas, resulting from storm events, can determine plant community development (Roman & Nordstrom 1988; Zaremba & Leatherman 1986) as well as the geomorphic evolution of barrier island systems (Kochel & Donlan 1986; Leatherman & Zaremba 1986).

Sea level rise is an issue for many federal coastal landholdings. Over the next century the rise in sea level along the Atlantic coast could range from 1-2m (Barth & Titus 1984). The environmental impacts of this sea level rise will be accelerated shoreline erosion, saltwater intrusion affecting groundwater, surface water and estuarine water, and the flooding of low lying areas. Sea level rise can disrupt coastal wetlands through saltwater intrusion, erosion, or inundation. Changes in vegetation or the conversion of wetlands to mudflats or open water may result (Titus 1991). Recent work suggests that marsh accretion rates are not keeping pace with sea-level rise, resulting in a shift of species dominance and a change in wetland community structure (Roman et al. 1997; Warren & Niering 1993). A comprehensive assessment of short and long-term processes influencing coastal ecosystems is needed to elucidate the complex relationship between geomorphic processes and community structure.

Some specific research areas related to coastal geomorphic processes are:

- Identify threats to park and refuge infrastructure and develop management protocols to address short-term and long-term processes.

- Identify and assess sensitive areas and develop protective management protocols for these areas.
- Determine the linkages between coastal geomorphic processes and habitat or ecosystem changes.
- Develop predictive models for coastal geomorphic change that provide guidance to natural resource managers.

Monitoring and Modeling Long-Term Changes

To effectively preserve and maintain ecosystem integrity within federal coastal lands research and monitoring activities are needed to evaluate the potential impacts from external and internal environmental threats and to provide a basis for resource management decisions. Predictive physical and ecological models are needed to provide a framework for the development of resource management scenarios to address all issues that confront federal land holdings along the Atlantic seaboard. Standardization of methodologies within research disciplines will aid the ability to assess ecosystem integrity at local and regional scales.

Data and Information Exchange

A data repository and information system will provide a central location where information can be efficiently and rapidly disseminated. The data and information system would facilitate communication among experts from partner institutions and federal scientists and managers. This system should be designed so that information is available via the internet and is easy to access. Information contained would include bibliographic information, geographic information system (GIS) data, results from recent investigations, and possibly a "SWAT" team of experts in various fields to provide technical assistance to federal scientists and managers in a timely fashion.

Program Activities of the North Atlantic Coast Cooperative Ecosystem Studies Unit

To complement the research and technical assistance activities of the CESU, programs will be established to encourage education of students and federal managers and scientists, and to facilitate information exchange.

Education

- **Students**

  NAC-CESU student fellowships will be offered for undergraduate and graduate students associated with CESU projects. Students would assist in projects conducted in or at federal coastal land holdings (e.g. National Parks, National Seashores, National Wildlife Refuges). This program could be

closely integrated with the University of Rhode Island's very successful undergraduate fellowship program (Partnership for the Coastal Environment).

- **Federal Resource Managers and Scientists**
  An educational exchange program will be developed by the NAC-CESU. Federal resource managers and scientists will come to the University of Rhode Island and the University of Maryland-Eastern Shore and interact with University scientists. University scientists could be encouraged to have sabbatical opportunities at federal land holdings (e.g. National Parks, National Seashores, National Wildlife Refuges). This educational exchange program will enhance the interaction and communication between federal and university personnel.

Information Exchange

- **Distance Learning**
  Opportunities for distance learning will be available.
- **Workshops**
  Workshops will be held to address immediate management issues, to frame research projects and to provide educational opportunities.
- **White Papers**
  White papers on CESU programs and activities will be published.
- **Web Presence**
  An internet website will be established to facilitate communication between CESU partners. Proceedings from workshops, white papers and project proposals will be available via the internet. Additional information exchange opportunities will develop as the NAC-CESU programs and research projects are initiated.

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Appendix I
Participants in the North Atlantic Coast CESU "strategic vision" workshop; January 11, 2000; University of Rhode Island, Coastal Institute.

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